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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/820,695	03/30/2001	Si Yi Li	015290-500	4162

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EXAMINER

OLSEN, ALLAN W

ART UNIT PAPER NUMBER

1763

DATE MAILED: 10/05/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/820,695

Applicant(s)

LI ET AL.

Examiner

Allan Olsen

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 21 July 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-24 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-24 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 20 March 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on June 28, 2004 has been entered.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 22-24 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 22 includes the following two recitations:

- 1) "...the etching gas comprising C₄F₈, CF₂H₂, N₂ and optionally Ar...."
- 2) "...the flow rate ratio of the fluorocarbon reactant to the nitrogen reactant is 30% or less..."

It is not clear if "the fluorocarbon reactant" is a reference to one of C₄F₈ and CF₂H₂ or if it is a reference to a mixture of C₄F₈ and CF₂H₂.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1, 4-9, 11, 14-16 and 19-21 are rejected under 35 U.S.C. 102(e) as being anticipated by U.S. Patent 6,693,042 issued to Sedigh et al. (hereinafter, Sedigh).

Sedigh teaches a method that comprises the plasma etching a low-k dielectric material such as fluorine-doped silicon oxide. Sedigh teaches using an etchant comprising a hydrofluorocarbon, for example, $C_xH_yF_z$ with a flow rate of 2-8 sccm (column 11, line 9) and nitrogen with a flow rate of 5-25 sccm (column 11, lines 14-16). Sedigh teaches patterning the dielectric etching by etching through an overlying hard masking material, such as undoped silicon oxide (column 9, lines 37-40). Sedigh teaches the dielectric layer overlies a conductive layer, for example aluminum (column 7, lines 11-18). Sedigh teaches that C_4F_8 , C_4F_6 , C_5F_8 , may be added to the etchant (column 10, line 38). Sedigh teaches etching patterns with features smaller than 0.2 microns (column 13, lines 18-20). Sedigh teaches the method is part a damascene process in which the etched feature is subsequently filled with metal (column 13, lines 10-30). Sedigh teaches using an apparatus with high and low frequency RF power (column 9, lines 5-8).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 22 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 5,843,847 issued to Pu et al. (hereinafter, Pu).

Pu teaches a method of the plasma etching doped glasses such as PSG and BPSG (column 3, lines 54-58). Pu teaches an oxide to resist selectivity of at least 10:1 (column 8, line 40). Pu teaches an etchant composition comprising a fluorocarbon selected from a second group that includes C_4F_8 , and a fluorocarbon selected from a first group that includes CF_2H_2 , and N_2 . Pu teaches a N_2 : (C_4F_8 + CF_2H_2) flow ratio of up to 5:1 and a CF_2H_2 : C_4F_8 ratio of 1:1 (column 5, line 64 - column 6, line 2; column 6, lines 20-24; column 7, line 6).

Pu does not explicitly teach the combination of C_4F_8 and CF_2H_2 .

It would have been obvious to one skilled in the art to use the C_4F_8 + CF_2H_2 combination because C_4F_8 is identified as the preferred fluorocarbon from the second group and CF_2H_2 is but one five fluorocarbons which belong to the first group.

Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Pu as applied to claim 22 above, and further in view of Koshiishi et al. in "Effect of Increasing the Upper Frequency on Dual Frequency Capacitive-Coupled-Plasma", Proceedings of Symposium on Dry Process, The Institute of Electrical Engineers of Japan, Nov 11-13, 1998, pp229-234 (hereinafter, Koshiishi).

Pu does not teach a dual frequency plasma system.

Koshiishi teaches etching in a dual frequency plasma system wherein the pedestal electrode and the showerhead electrode are provided with different frequencies of RF energy.

It would have been obvious to one skilled in the art to use the RF frequency scheme of Koshiishi because Koshiishi teaches that this enables greater control over the etching process. For example, Koshiishi teaches this enables the use of lower pressure, which in turn improves the extent of microloading

Claims 1-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. patent 6,455,411 issued to Jiang et al. (hereinafter, Jiang) in view of Koshiishi.

Jiang teaches plasma etching a low-k dielectric layer. Jiang teaches using an etchant comprising a fluorocarbon and a greater amount of nitrogen. Jiang teaches etching low-k dielectric layers (106 and 108) through an overlying patterned layer of SiN (capping layer 110). The patterned SiN functions as a mask for the subsequent etching of the underlying layer of low-k dielectric. Jiang teaches etching a layer of low-k dielectric that is disposed upon an underlying layer of SiC (104). C₄F₈, C₄F₆, and CH₂F₂ are among the fluorocarbons etchants that Jiang teaches. Jiang teaches adding Ar to the etchant. Jiang teaches an etchant mixture consisting of C₄F₈, N₂ and

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Ar. Jiang teaches etching a layer of low-k dielectric material that overlies a barrier layer comprising TaN. Jiang teaches using a fluorocarbon flow rates that is less than 30% of the nitrogen flow rate. Jiang teaches the etched feature is filled with metal. See: column 2, lines 56-58; column 2, line 65 - column 3, line 26; column 3, lines 33-63; column 4, lines 1-2, 26-46.

Jiang does not teach etching a feature with at least a 5:1 aspect ratio. Jiang does not teach a dual frequency plasma system. Jiang does not teach using an etchant that consist essentially of C5F8, N2 and Ar. Jiang does not teach the temperature of the substrate support.

It would have been obvious to one skilled in the art to use an etchant consisting of C5F8, N2 and Ar because Jiang teaches an etchant consisting of C4F8, N2 and Ar and Jiang also teaches that C4F8 and C5F8 are functional equivalents as the fluorocarbon component of the etchant mixture. The substitution of equivalents is obvious and requires no express motivation as long as the prior art recognizes the equivalency¹. It would have been obvious to one skilled in the art that Jiang was applicable to etching of features with a 5:1 aspect ratio because Jiang teaches etching a contact hole to a depth of 10,500 angstroms and the industry standard for the size of contact holes at the time of Jiang's disclosure was .2 microns or less and in combination with an etching depth of 10,500 angstroms, this corresponds to a 5:1 aspect ratio.

¹ *In re Fount* 213 USPQ 532 (CCPA 1982); *In re Siebentritt* 152 USPQ 618 (CCPA 1967); *Graver Tank & Mfg. Co. Inc. v. Linde Air Products Co.* 85 USPQ 328 (USSC 1950).

Koshiishi teaches etching in a dual frequency plasma system wherein the pressure is up to 11 Pa (82.5 mTorr) and the pedestal and showerhead electrodes are provided with different frequencies of RF energy.

It would have been obvious to one skilled in the art to use the RF frequency scheme of Koshiishi because Koshiishi teaches that this enables greater control over the etching process. For example, Koshiishi teaches this enables the use of lower pressure, which in turn improves the extent of microloading.

It would have been obvious to one skilled in the art to appropriately adjust the process parameters such as the temperature of the substrate support because optimization of such parameters is considered to be obvious.²

Response to Arguments

Applicant's arguments, filed June 28, 2004, with respect to rejections relying on Maex and Ma have been fully considered and are persuasive. Therefore, the rejections have been withdrawn. However the arguments are considered moot in view of the above new grounds of rejection.

² "Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however, changes such as these may impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely degree from the results of the prior art... such ranges are termed "critical ranges and the applicant has the burden of proving such criticality... More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation."

In re Aller 105 USPQ 233, 255 (CCPA 1955). See also *In re Waite* 77 USPQ 586 (CCPA 1948);

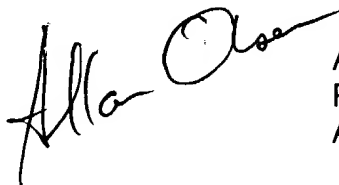
In re Scherl 70 USPQ 204 (CCPA 1946); *In re Irmischer* 66 USPQ 314 (CCPA 1945); *In re Norman* 66 USPQ 308 (CCPA 1945); *In re Swenson* 56 USPQ 372 (CCPA 1942); *In re Sola* 25 USPQ 433 (CCPA 1935); *In re Dreyfus* 24 USPQ 52 (CCPA 1934).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Allan Olsen whose telephone number is 571-272-1441. The examiner can normally be reached on M-F 1-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Greg Mills can be reached on 571-272-1439. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

A handwritten signature in black ink, appearing to read 'Allan Olsen', with a stylized flourish at the end.

Allan Olsen
Primary Examiner
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